CLAIM LISTING:

1. (Previously Presented) A method for fabricating a capacitor of a semiconductor device, the method comprising:

forming a lower electrode on a semiconductor substrate;

forming a dielectric layer on the lower electrode by

nitriding an upper surface of the lower electrode using in-situ plasma before forming a first amorphous TaON thin film;

forming the first amorphous TaON thin film on the lower electrode;

annealing the first amorphous TaON thin film in an NH3 atmosphere;

forming a second amorphous TaON thin film on the lower electrode; and

annealing the second amorphous TaON thin film to form a multilayer TaON dielectric film; and

forming an upper electrode over the TaON dielectric film.

2. (Previously Presented) The method according to claim 1, wherein forming the lower electrode further comprises one of:

1) forming a single conductive layer, the single conductive layer being formed from at least one material selected from a group consisting of doped polysilicon and metal, and

2) forming a plurality of conductive layers, the plurality of conductive layers comprising at least two layers, the plurality of conductive layers being formed from at least one material selected from a group consisting of doped polysilicon and metal; and

further wherein forming the upper electrode further comprises one of:

1) forming a single conductive layer, the single conductive layer being formed from at least one material selected from a group consisting of doped polysilicon and metal, and

2) forming a plurality of conductive layers, the plurality of conductive layers comprising at least two layers, the plurality of conductive layers being formed from at least one material selected from a group consisting of doped polysilicon and metal.

3. (Previously Presented) The method according to claim 2, wherein the metal may be selected from the group consisting of TiN, Ti, TaN, W, WN, WSi, Ru, RuO_2, Ir, and Pt.

4. (Previously Presented) The method according to claim 1, wherein forming the lower electrode further comprises forming a layer of doped polysilicon, the surface of the doped polysilicon being characterized by a hemispherical grain structure.

5. (Previously Presented) The method according to claim 1, wherein forming the lower electrode comprises forming a layer of polysilicon and further comprises removing a natural oxide film on the surface of the lower electrode before forming the first amorphous TaON thin film,

the natural oxide film being removed by

an in-situ dry cleaning process, the dry cleaning process utilizing HF, SiF_6, or NF_6,

or an ex-situ wet cleaning process, the wet cleaning process utilizing an HF solution.

6. (Previously Presented) The method according to claim 5, wherein removing the natural oxide film further comprises cleaning the lower electrode with a NH_4OH solution, H_2SO_4 solution, or a combination thereof.

7. (Previously Presented) The method according to claim 1, wherein forming the first amorphous TaON thin film further comprises depositing a first TaON thin film in a LPCVD chamber maintained at a temperature of not more than about 600°C; and

further wherein forming the second amorphous TaON thin film further comprises depositing a second TaON thin film in a LPCVD chamber maintained at a temperature of not more than about 600°C.

8. (Previously Presented) The method according to claim 7, wherein depositing the amorphous TaON thin films further comprises:

evaporating $Ta(OC_2H_5)_5$ in an evaporator maintained at a temperature of 150 to 200°C to obtain a Ta-containing chemical vapor;

transporting the Ta-containing chemical vapor through a supply tube, the supply tube being maintained at a temperature of at least 150°C; and

injecting the $Ta(OC_2H_5)_5$ vapor into the LPCVD chamber.

9. (Previously Presented) The method according to claim 1, wherein forming at least one of the amorphous TaON thin films further comprises:

supplying a controlled quantity of the Ta-containing chemical vapor to the LPCVD chamber, the quantity being controlled by a mass flow controller;

supplying a controlled quantity of a reaction gas to the LPCVD chamber, the reaction gas comprising NH_3; and

maintaining the LPCVD chamber within a temperature range between 300 and 600° C and at a pressure of less than 10 Torr, to thereby induce a surface reaction between the Ta-containing chemical vapor and the reaction gas.

10. (Previously Presented) The method according to claim 9, wherein forming at least one of the amorphous TaON thin films further comprises:

supplying a controlled quantity of O2 gas to the LPCVD, the quantity ranging from 5 sccm to 500 sccm.

11. (Previously Presented) The method according to claim 9 , wherein forming at least one of the amorphous TaON thin films further comprises:

spraying the Ta-containing chemical vapor into the LPCVD chamber through a gas distribution head and onto the lower electrode in a direction substantially perpendicular to the lower electrode.

12. (Previously Presented) The method according to claim 9, wherein forming at least one of the amorphous TaON thin films further comprises:

spraying the Ta-containing chemical vapor into the LPCVD chamber through an injector configured and arranged to establish a parabolic flow of the Ta-containing chemical vapor through the LPCVD chamber and onto the lower electrode.

13. (Previously Presented) The method according to claim 12, wherein forming at least one of the amorphous TaON thin films further comprises

spraying the Ta-containing chemical vapor into the LPCVD chamber through a first injector; and

spraying the reaction gas into the LPCVD chamber through a second injector, the first and second injectors being configured and arranged to establish a counter-current flow of the gas and the vapor through the LPCVD chamber and onto the lower electrode.

14. (Previously Presented) The method according to claim 1, wherein the annealing steps further comprise a plasma treatment in an NH_3 or N_2O atmosphere.

15. (Previously Presented) The method according to claim 1, wherein the annealing steps further comprise a low-temperature annealing process in a UV-O_3 or O_3 atmosphere.

16. (Previously Presented) The method according to claim 1, wherein the annealing steps further comprise heating the amorphous TaON thin film to a temperature between 650 and 950°C under an atmosphere of N_2O, O_2, or N_2.

17. (Previously Presented) The method according to claim 1 wherein the step of nitriding an upper surface of the lower electrode using in-situ plasma is applied under an NH_3 atmosphere for 1 to 5 minutes.

18. (Previously Presented) The method according to claim 1 wherein forming the lower electrode further comprises treating the surface of the lower electrode with a plasma in an N_2O atmosphere to form a thin, homogeneous, oxide layer before forming the first amorphous TaON thin film.

19. (Previously Cancelled)

20. (Previously Presented) A method for fabricating capacitors for semiconductor devices, comprising:

forming a lower electrode on a semiconductor substrate;

nitriding an upper surface of the lower electrode in an NH_3 atmosphere;

forming a first amorphous TaON thin film over the lower electrode;

annealing the first amorphous TaON thin film in an NH_3 atmosphere;

forming a second amorphous TaON thin film;

annealing the second amorphous TaON thin film at least once, thereby forming a TaON dielectric film having a multi-layer structure; and

forming an upper electrode over the TaON dielectric film.